

WHAT IS CLAIMED IS:

1. An isolated origin of replication for *F. nucleatum* that comprises at least two copies of an iteron, the iteron having a nucleic acid sequence of SEQ ID NO:3.

2. The isolated origin of replication of claim 1, wherein the isolated origin of replication comprises two to six copies of the iteron.

3. The isolated nucleic acid of claim 1, wherein the isolated origin of replication comprises a nucleic acid sequence of SEQ ID NO:4.

4. The isolated nucleic acid of claim 1, wherein the isolated origin of replication comprises a nucleic acid sequence of nucleotide position 3936 to 4481 of plasmid pFN1.

5. An isolated nucleic acid encoding a RepA protein for *F. nucleatum*, the nucleic acid:

(a) encoding a protein that has greater than about 80% amino acid sequence identity to a polypeptide having a sequence of SEQ ID NO:1; or

(b) selectively binding to polyclonal antibodies generated against SEQ ID NO:1.

6. The isolated nucleic acid of claim 5, wherein the nucleic acid encodes a polypeptide having a sequence of SEQ ID NO:1.

7. The isolated nucleic acid of claim 5, wherein the nucleic acid encodes a polypeptide having a molecular weight of about 44.8 kDa.

8. The isolated nucleic acid of claim 5, wherein the nucleic acid is from *F. nucleatum*.

9. The isolated nucleic acid of claim 5, wherein the nucleic acid has a sequence of SEQ ID NO:2.

10. An isolated nucleic acid molecule comprising a 2.36 kb DNA fragment generated by cleaving plasmid pFN1 with restriction endonucleases *AvrII* and *ScaII*.

1 11. An isolated nucleic acid molecule comprising a 0.9 kb DNA  
2 fragment generated by cleaving plasmid pFN2 with restriction endonucleases *HincII* and  
3 *HpaII*.

1 12. An isolated RepA protein for *F. nucleatum*, the RepA protein  
2 having:

3 (a) greater than about 80% amino acid sequence identity to a  
4 polypeptide having a sequence of SEQ ID NO:1; or

5 (b) selectively binding to polyclonal antibodies generated against SEQ  
6 ID NO:1.

1 13. The isolated RepA protein of claim 12, wherein the polypeptide  
2 has greater than about 97% amino acid identity to a polypeptide having a sequence of  
3 SEQ ID NO:1.

1 14. The isolated RepA protein of claim 12, wherein the polypeptide  
2 has the amino acid sequence of SEQ ID NO:1

1 15. An isolated plasmid for replicating in *F. nucleatum*, the plasmid  
2 comprising an origin of replication that comprises at least two copies of an iteron, the  
3 iteron having a nucleic acid sequence of SEQ ID NO:3.

1 16. The plasmid of claim 15, wherein the origin of replication  
2 comprises between two to six copies of the iteron.

1 17. The plasmid of claim 15, wherein the origin of replication  
2 comprises a nucleic acid sequence of SEQ ID NO:4.

1 18. The plasmid of claim 15, the plasmid further comprising a marker  
2 gene.

1 19. The plasmid of claim 18, wherein the marker gene is an antibiotic  
2 resistance gene.

1 20. The plasmid of claim 15, wherein the origin of replication is  
2 recombinantly inserted into the plasmid.

1 21. An isolated plasmid for replicating in *F. nucleatum*, the plasmid  
2 comprising a nucleic acid encoding a RepA protein for *F. nucleatum*, the nucleic acid:

3 (a) encoding a protein that has greater than about 80% amino acid  
4 sequence identity to a polypeptide having a sequence of SEQ ID NO:1; or

5 (b) selectively binding to polyclonal antibodies generated against SEQ  
6 ID NO:1,

7 provided that the nucleic acid encoding the RepA protein has other than  
8 the nucleic acid sequence of SEQ ID NO:5.

1 22. The plasmid of claim 21, wherein the nucleic acid encodes a  
2 polypeptide having a sequence of SEQ ID NO:1.

1 23. The plasmid of claim 21, wherein the nucleic acid has a sequence  
2 of SEQ ID NO:2.

1 24. The plasmid of claim 21, the plasmid further comprising a marker  
2 gene.

1 25. The plasmid of claim 24, wherein the marker gene is an antibiotic  
2 resistance gene.

1 26. The plasmid of claim 20, wherein the nucleic acid encoding a  
2 RepA protein is recombinantly inserted into the plasmid.

1 27. The plasmid of claim 15, the plasmid further comprising a nucleic  
2 acid encoding a RepA protein for *F. nucleatum*, the nucleic acid:

3 (a) encoding a protein that has greater than about 80% amino acid  
4 sequence identity to a polypeptide having a sequence of SEQ ID  
5 NO:1; or

6 (b) selectively binding to polyclonal antibodies generated against SEQ  
7 ID NO:1,

8 provided that the nucleic acid encoding the RepA protein has other than  
9 the nucleic acid sequence of SEQ ID NO:5.

1 28. The plasmid of claim 27, wherein the nucleic acid encodes a  
2 polypeptide having a sequence of SEQ ID NO:1.

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1 29. The plasmid of claim 27, wherein the nucleic acid has a sequence  
2 of SEQ ID NO:2.

1 30. The plasmid of claim 27, the plasmid further comprising at least  
2 one marker gene.

1 31. The plasmid of claim 30, wherein the marker gene is an antibiotic  
2 resistance gene.

1 32. The plasmid of claim 27, the plasmid further comprising a  
2 transcription cassette comprising a nucleic acid of interest operably linked to a promoter.

1 33. An isolated plasmid for replicating in *F. nucleatum*, the plasmid  
2 comprising:

3 (a) a nucleic acid sequence of nucleotide position 3936 to 4481 of  
4 plasmid pFN1;

5 (b) a 2.36 kb DNA fragment generated by cleaving plasmid pFN1 with  
6 restriction endonucleases *AvrII* and *ScaII*; or

7 (c) a 0.9 kb DNA fragment generated by cleaving plasmid pFN2 with  
8 restriction endonucleases *HincII* and *HpaII*.

1 34. An isolated plasmid designated pFN1 that has a GenBank  
2 Accession No. AF159249.

1 35. An isolated plasmid designated pFN2 that have partial restriction  
2 maps as shown in Figure 1A, 3 and 5.

1 36. An isolated plasmid designated pFN3 that has a partial restriction  
2 map as shown in Figure 1A.

1 37. A shuttle vector comprising an origin of replication functional in *E.*  
2 *coli* and an origin of replication functional in *F. nucleatum*, wherein the origin of  
3 replication functional in *F. nucleatum* comprises at least two copies of an iteron having a  
4 nucleic acid sequence of SEQ ID NO:3.

1 38. The shuttle vector of claim 37, wherein the origin of replication  
2 functional in *F. nucleatum* comprises between two to six copies of the iteron.

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1 39. The shuttle vector of claim 37, wherein the origin of replication  
2 functional in *F. nucleatum* comprises a nucleic acid sequence of SEQ ID NO:4.

1 40. The shuttle vector of claim 37, wherein the origin of replication  
2 functional in *F. nucleatum* comprises a nucleic acid sequence of nucleotide position 3936  
3 to 4481 of plasmid pFN1.

1 41. The shuttle vector of claim 37, the vector further comprising a  
2 nucleic acid encoding a RepA protein for *F. nucleatum*, the nucleic acid:

3 (a) encoding a protein that has greater than about 80% amino acid  
4 sequence identity to a polypeptide having a sequence of SEQ ID NO:1; or

5 (b) selectively binding to polyclonal antibodies generated against SEQ  
6 ID NO:1.

1 42. The shuttle vector of claim 41, wherein the nucleic acid encoding  
2 the RepA protein for *F. nucleatum* encodes a polypeptide having a SEQ ID NO:1.

1 43. The shuttle vector of claim 41, wherein the nucleic acid encoding  
2 the RepA protein for *F. nucleatum* has a sequence of SEQ ID NO:2.

1 44. The shuttle vector of claim 41, the vector further comprising at  
2 least one marker gene.

1 45. The shuttle vector of claim 44, wherein the marker gene is an  
2 antibiotic resistance gene.

1 46. The shuttle vector of claim 41, wherein the vector comprises an  
2 *ermF-ermAM* cassette.

1 47. The shuttle vector of claim 41, the vector further comprising a  
2 transcription cassette comprising a nucleic acid of interest operably linked to a promoter.

1 48. A shuttle vector designated pHS17 that has a partial restriction map  
2 as shown in Figure 1A.

1 49. A host cell comprising the plasmid of claim 18.

1 50. The host cell of claim 49, wherein the host cell is *F. nucleatum*.

- 1 51. A host cell comprising the plasmid of claim 24.
- 1 52. The host cell of claim 51, wherein the host cell is *F. nucleatum*
- 1 53. A host cell comprising the plasmid of claim 30.
- 1 54. The host cell of claim 53, wherein the host cell is *F. nucleatum*.
- 1 55. A host cell comprising the shuttle vector of claim 37.
- 1 56. The host cell of claim 55, wherein the host cell is *F. nucleatum*.
- 1 57. The host cell of claim 55, wherein the host cell is *E. coli*.
- 1 58. A method of transforming a *F. nucleatum* with the plasmid of  
2 claim 21.
- 1 59. A method of transforming a *F. nucleatum* with the plasmid of  
2 claim 15.
- 1 60. A method of transforming a *F. nucleatum* with the plasmid of  
2 claim 21.
- 1 61. A method of transforming a *F. nucleatum* with the plasmid of  
2 claim 27.
- 1 62. A method of transforming a *F. nucleatum* with the shuttle vector of  
2 claim 37.
- 1 63. A method of transforming an *E. coli* with the shuttle vector of  
2 claim 37.

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